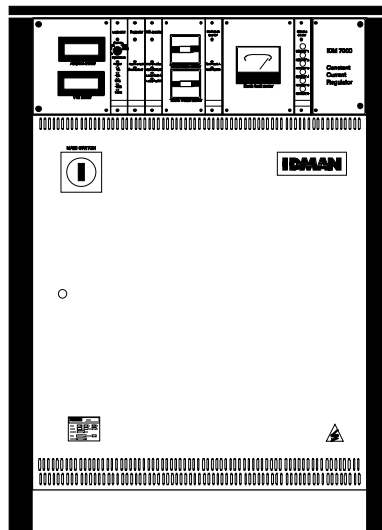


IDM7000 – CONSTANT CURRENT REGULATOR



User Manual

IDM 7000 – CONSTANT CURRENT REGULATOR**User Manual*****Versions covered by this manual:***

IDM 7000- /1-30 KVA	Constant current regulator 1-30 kVA
1	Direction changer
2-6	Circuit selector
F	FAA-monitor IDM 7000-03
E	Earth fault monitor
S	Surge arresters
X	Extra monitor

Revision index

Revision:	Author	Date:	Description
T-7000-2	JK	30.05.1994	
T-7000-2d	JK	01.08.1996	Cards 01b, 03b, 04c
T-7000-2e	JK/JN	24.08.1998	Card 03d
T-7000-2f	JK/JN	29.10.1998	Card 01c
T-7000-2g	JR	28.05.2001	New format

WARNING !

The equipment contains high voltage circuits and components which may cause a life hazard !

The doors and covers should be only opened by qualified personnel.

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1. GENERAL

1.1 AIRPORT LIGHTING SYSTEMS

Airport lighting systems are used as visual aids to indicate a pilot the right approach path and the runway with its sections. After landing, taxiing is guided by the lighting system. The main principle is to indicate the edges, centrelines and some other important lines of the runway with numerous relatively low powered and precisely aligned fittings instead of trying to illuminate the whole surface of the runway.

The lighting systems are normally based on *ICAO's* (International Civil Aviation Organisation) recommendations of which *Annex 14* deals with the lighting systems. According the Annex 14 the lighting systems are classified into following categories:

a) Non precision approach runway

Runway which is equipped with lighting system and navigation system which at least gives directional guidance for direct approach.

b) Precision approach runway CAT I

Runway that is equipped with lighting system and ILS system and which facilitates operations down to 60m decision height and 800m RVR (Runway Visual Range).

c) Precision approach runway CAT II

Runway that is equipped with lighting system and ILS system and which facilitates operations down to 30m decision height and 400m RVR (Runway Visual Range).

d) Precision approach runway CAT III

Runway that is equipped with lighting system and ILS for approach and runway operations and which is arranged to following sub-categories:

A- Runway for operations down to 200m RVR and where decision height is not anymore specified. The lighting system is needed on the final phase of landing.

B- Runway for operations down to 50m RVR and where decision height is not anymore specified. The lighting system is only needed for taxiing operations.

C- Runway for operations where visual guidance is not anymore needed.

Table 1. Sub-systems of a lighting system (see figure 1)

Number	Lighting system	Abbreviation
1	Approach lighting system	APCH
2	Threshold lighting system	THR
3	Precision approach path indicator system	PAPI
4	Runway edge and end lighting system	RWYE
5	Runway centreline lighting system	RCL
6	Touchdown zone lighting system	TDZ
7	Taxiway edge lighting system	TWYE
8	Taxiway central lighting system	TCL
9	Stop-bar lighting system	SB

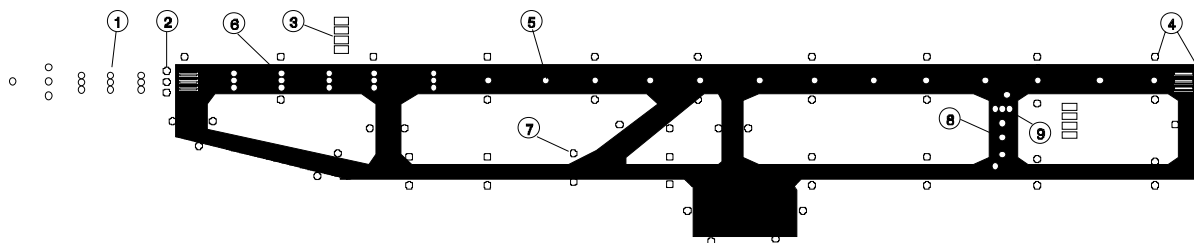


Figure 1. A lighting system lay-out with sub-systems

1.2 CIRCUIT DESIGN

According ICAO's Annex 14 and *Aerodrome design manual part 5* the circuits should be arranged for a *precision approach runway* (CAT I..III) as follows.

Table 2. Circuit partage

Approach lighting system	At least 2 interleaved circuits
Threshold lighting system	At least 2 interleaved circuits, can be also integrated into APCH s
PAPI	At least 2 interleaved circuits, interleaving to be done in each unit
Runway lighting system	At least 2 interleaved circuits
Taxiway edge lighting system	Single circuit may be used
Taxiway centreline lighting system	At least two interleaved circuit for CAT III-areas. Other areas single circuits may be used. Circuits to be in sections to enable selective switching.
Stop-bar lighting system SB	2 interleaved individual circuits for each SB

Interleaving should be done in such a way that the light patterns and colour coding of the sub-systems should not change if one of the circuits should fail. The light fittings are fed by a supplying device that normally provides 5 brilliancy steps and can be controlled with remote-or local control. The ratings of the light fittings usually vary from 45 to 200W and the circuits up to 30 kW. Two kinds of circuits are normally used: series and parallel circuit.

1.3 SERIES CIRCUIT

In series circuit the light fittings are connected in series with 1/1 isolation transformers and 1-core airport lighting cable. The circuit is fed with constant current regulator (CCR) which adjusts constant current for the light fittings by regulating its output voltage. Connections are made with primary and secondary connectors. See Figure 2.

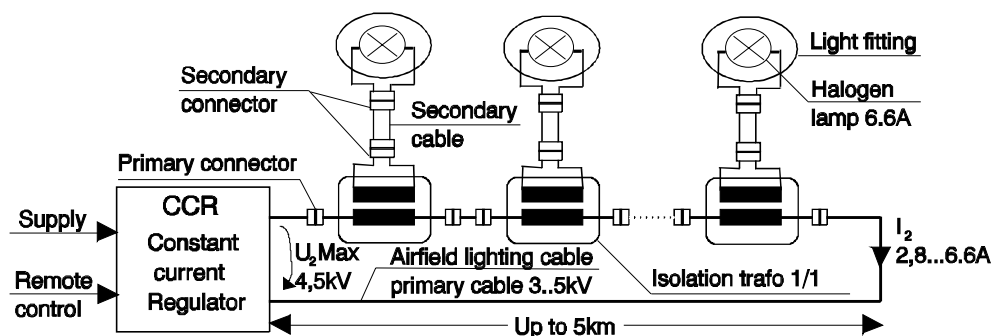


Figure 2. Series circuit

Series circuit gives following main advantages:

- Equal brilliancy for all light fittings in the circuit (equal current)
- Small power loss and cable size (Relatively low current 6.6A)
- Wide range of intensity control (0,3 ...100%)
- 1-point ground faults do not effect the operation of the system and 2-point faults only partially.

On the other hand high output voltage (up to 5kV) requires care to be taken when working with the circuits.

1.4 GROUNDING OF A SERIES CIRCUIT

According the Aerodrome design manual part 5 all the equipment in the electrical stations should be grounded. A ground wire should also be installed with the series circuit cables into which all supports of elevated lights and secondary of the isolation transformers should be connected. The circuit is normally isolated from the ground (CCR main transformer) but in case of an earth fault and simultaneous high voltage break through proper grounding will protect the personnel from electrical shocks. See figure 3 for details.

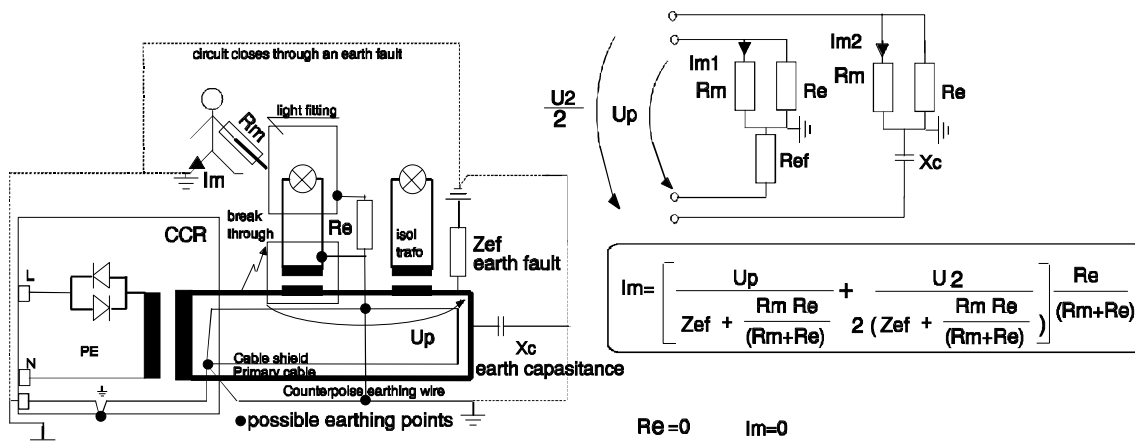


Figure 3. Effects of grounding of a series circuit

U_p (potential difference) between the earth fault point and the break through point in connection with the earth fault resistance R_e , earth capacitance X_c and human resistance R_m defines the current that would go through a human being touching the break through point. Currents from 30mA are considered to be fatal. Proper grounding would by-pass the R_m and therefore give protection against the ground fault. However, there are arguments for and against the grounding i.e. local conditions and national regulations should be considered when designing the grounding system.

1.5 SELECTING THE REGULATOR SIZE

When selecting a regulator for a lamp load, following things should be considered:

- The regulator rating given in kVA is the output power of the CCR. When supplying a load with unity power factor, the rating can be considered in kW.
- The input power is approx. 1,1 times the output power.
- In calculation lamp load, auxiliary load, primary- and secondary cable loads, isolation transformer characteristic factors and possible under voltage reserve should be taken in account.

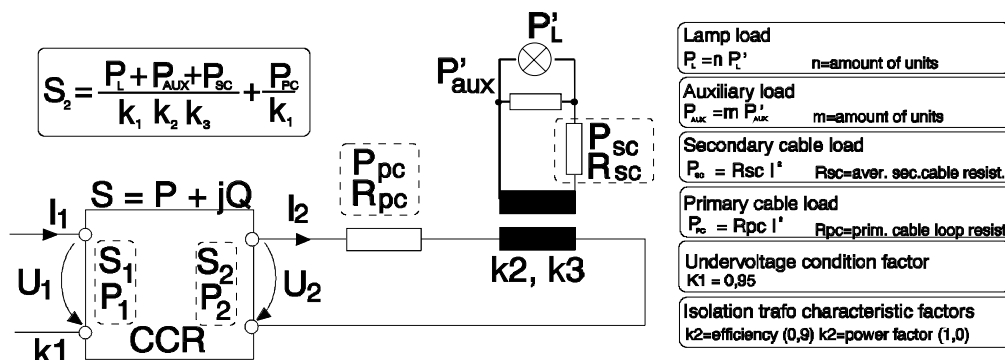


Figure 4. Formula for selecting a CCR

The isolation transformers can normally tolerate 10%-20% overload ($P_L + P_{aux} + P_{sc}$). If further overloaded the output current decreases. See following Table 3 for selecting correct secondary cable cross-sections for different transformers and cable lengths.

Table 3. Maximum cable lengths for different isolation transformers (20% overload)

Trafo size / W	2.5mm2 Cu maximum length/m (R=0.0165 ohm/m, P=0.72 W/m)	4mm2 Cu maximum length/m (R=0.0103 ohm/m, P=0.44 W/m)
45	12	20
65	18	29
100	28	45
150	42	67
200	56	90

A CCR may be slightly oversized for lamp faults. When a lamp has failed (filament burnt open) transformers secondary side will open and the transformer be saturated which will increase the voltage over it (typically 40-100V/ 200W transformer). In case of many lamp faults the voltage can rise so high that the regulator is not capable to maintain the output current. Normally regulators can tolerate up to 30-50% lamp failures depending of the saturation voltage of the isolation transformers. This can be prevented by oversizing the CCR or using transformers with lower saturation voltage and by efficient lamp failure monitoring. Primary cable size and its protective fuse can be estimated from the following Table 4

Table 4. Estimating primary cable and fuse size(supply voltage 230V).National regulations and installation methods must be taken in account.

S/kVA	I _{max} /A	Cable/Cu	Fuse
3	15	2,5mm2	16A
5	24	4mm2	25A
7,5	36	10mm2	50A
10	48	10mm2	63A
12	58	16mm2	63A
17	82	25mm2	100A
20	96	25mm2	100A
25	120	35mm2	125A

1.6 PARALLEL CIRCUIT

In parallel circuit the light fittings are connected parallel to a supplying device. The fittings do not have equal brilliancy because of the voltage losses of the circuit. Also power losses are high due relatively high current in the circuit. Parallel circuits are mostly used with taxiway/apron applications that are located close to electrical stations.

2. CCR OPERATING PRINCIPLE

2.1 REGULATOR CIRCUIT BASIC THEORY

Basically a regulator circuit consists of three different elements:

- The regulator element
- The control element
- The feedback element

The task of a regulator is to keep a desired output value determined by a set value. The regulator checks if there is a difference between these two values and adjusts the output accordingly through the control element. In case of a CCR the regulator is located in the regulator card. The control element is a thyristor pair that chops the sinusoidal input voltage and the feedback element consists of a current transformer and a RMS-computer in the regulator card.

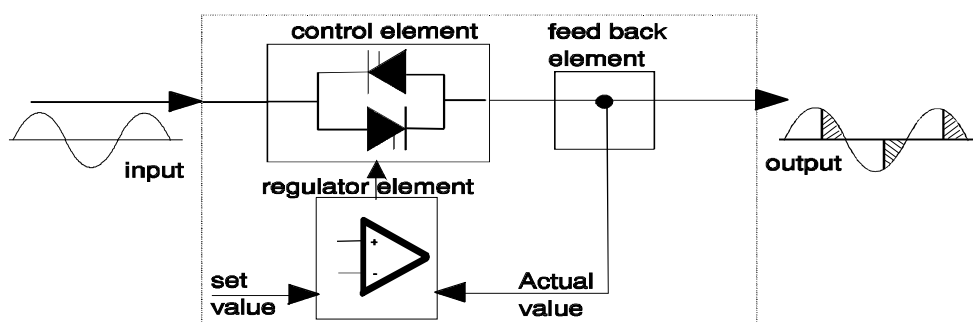


Figure 5. Operating principle of a regulator

In a CCR the output voltage defines the output current which is kept constant despite changes of output load or supply voltage.

2.2 CCRS FUNCTION BLOCKS AND THEIR OPERATIONS

Main functions of a CCR are:

- to define and maintain desired current values (brightness levels)
- to isolate the AFL-circuit from the ground
- to monitor the status of the circuit
- to compensate changes of the load and supply voltage

The CCR consists of three different function blocks:

- the power unit
- the high voltage unit
- the electronic unit

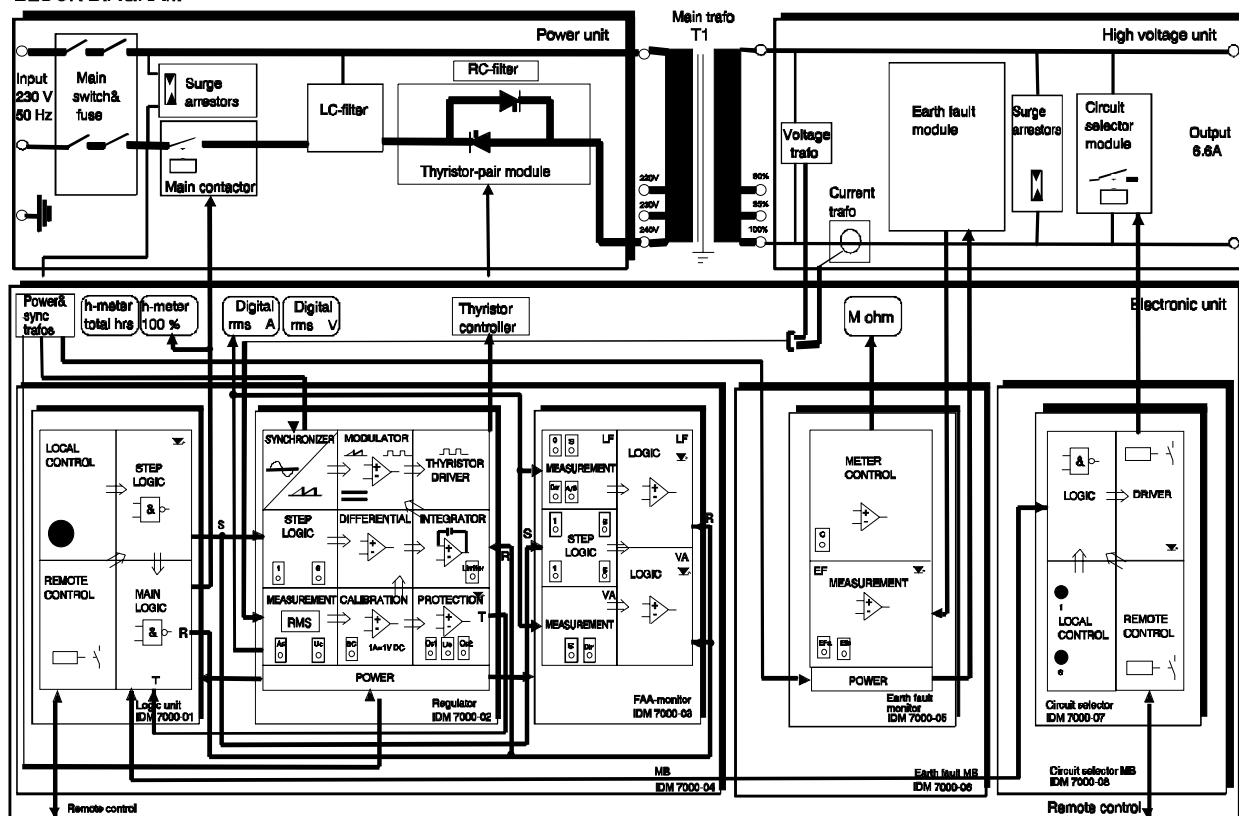
BLOCK DIAGRAM

Figure 6. Block diagram of a IDM 7000 constant current regulator

2.2.1 Power unit

The power unit consists of following main components.

Main switch and fuse

The main switch connects the supply and the main fuse protects the power unit from over current.

Surge arrester (optional S)

Optional surge arresters protects the power unit from over voltage surges.

Main contactor

The main contactor switches the regulator on or off. Switching is made in such a way that the contacts of the contactor are currentless in order to avoid transients and to provide maximum operating life for the contacts.

Passive LC-filter

The passive LC-filter protects the power unit from high frequency disturbances. The choke of the filter also limits fast current changes in the circuit in case of sudden load changes.

Thyristor module with RC-filter and thyristor controller

The thyristor pair is the actual regulating element of the CCR. It chops the sinusoidal mains voltage to form desired RMS-voltages that define the output current of the CCR. The thyristors are triggered by the thyristor controller which is driven by the regulator card.

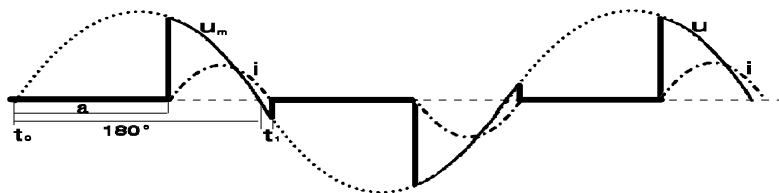


Figure 7. Voltage and current curves as a function of time. Supply voltage dash line.

The triggering angle α defines the moment when the thyristor is ignited (opened) and the current starts to flow through it. The thyristor will close itself at the moment (t_1) when the current ceases to flow through it.

When the voltage is chopped the current will lag the voltage and thus the inductive power factor will be smaller the more the voltage is chopped. The need for chopping depends on the desired current level and the CCRs capacity /load rating ratio. When the voltage is chopped there will be some harmonic distortion which is proportional to the triggering angle and the current drawn from the mains.

Main transformer

The main transformer defines the capacity of the CCR and also isolates the a/c-circuit from the ground. The transformer has got 3 tapping both on primary and secondary sides with which the capacity can be adjusted to match with the load rating.

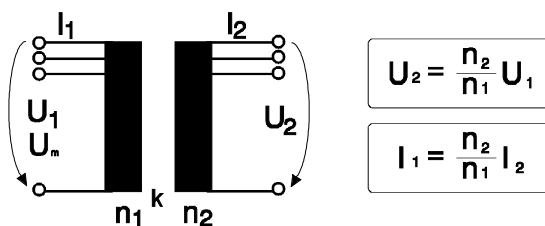


Figure 8. Adjusting of a transformer to a circuit

The input current and its harmonic content depend practically only on the output current and the transforming ratio n_2/n_1 . On the other hand the losses of the CCR which primarily come from the main transformer and the choke and depend mainly on the primary current (e.g. depend on the CCR capacity not the load rating). In conclusion this all means that if a CCR is well matched with a given load it will lead to following benefits:

- better power factor
- better efficiency compared to the load rating
- minimum input current level compared to the load rating
- minimum harmonic distortion

Matching is done by choosing correct CCR size and further by using CCRs main transformers tappings. The benefits will be even greater when UPS or generator sets are used as a power supply.

2.2.2 High voltage unit

The high voltage unit which in CCRs over 12 kVa forms a separated cabinet and consists of following main components:

Current and voltage transformers

These transformers provide the feedback information for the regulator

Surge arresters (optional S)

The arresters protect the CCR from over voltage surges (e.g. lightning). The arresters will automatically recover after they have operated. When the arrester has failed it will make an earth fault and can be therefore identified with the earth fault monitor.

Direction switch or circuit selector contactors (Optional)

These contactors will switch the selected circuits. Switching is made currentless in order to avoid transients and to provide maximum life span for the contacts.

Earth fault module IDM-MV

This card connects the earth fault monitor with the circuit and ground and provides the measuring signal for the earth fault monitor.

2.2.3 Electronic unit

The electronic unit consists of following main components.

a) Logic unit IDM 7000-01

The card includes the remote and local control functions, reset logic, main contactor control logic and optional direction changer logic.

b) Regulator IDM 7000-02

The card includes the actual regulator of the CCR including TRMS-computers, synchroniser, modulator, reference generators, regulator amplifiers, protection electronics and the power for the electronics.

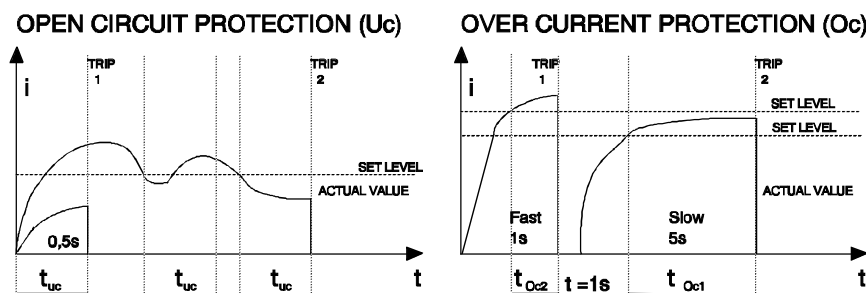


Figure 9. Operating principle of the protections

The card includes following protective devices:

Open circuit protection

If output current does not reach the set level or decreases under it the regulator will trip off in 0,5s and the red "Open circuit" led will lit on the regulator card. To reset it turn the CCR off either by local or remote control.

Over current protection

If the output current in the circuit increases over the set values the regulator will trip off as follows. Red "Over current" led on the regulator card will light. To reset it turn off the CCR. See figure 9.

- level 1 (Oc1), slow protection 5s
- level 2 (Oc2), fast protection 1s

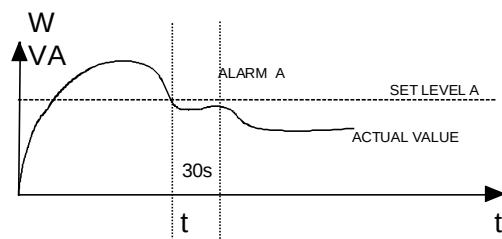
Under voltage monitoring (in the regulator card)

If the electronic (+ and - power) fuses operate or the mains voltage decreases 15% or more under the nominal value the regulator will trip off. This protects the power circuit from under voltage eg. main contactor unstability.

c) FAA-monitor IDM 7000-03 (optional F)

This optional card includes power calculation computers and voltage curve measurement, reference generators and monitoring logic for lamp fault, current fault and VA-drop monitoring.

VA-DROP MONITORING



CURRENT FAULT MONITORING (CF)

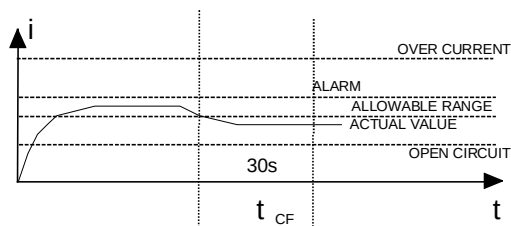


Figure 10. Operating principle of the monitoring circuits

VA-drop monitoring (in the FAA-monitor card)

If the apparent power (S/VA) of the circuit decreases 10% or more the red led "10% VA-drop" will light after 30 seconds on the FAA-monitor. The function works with all brilliancy steps and can be reset by turning the regulator off.

Lamp fault monitoring (in the FAA-monitor card)

For lamp fault two fault levels can be chosen. If the actual lamp fault voltage increases over the pre-set values first red "Lamp fault a" led will lit on the monitor card. If the actual lamp fault voltage increases further the red "Lamp fault b" led will light. When using a circuit selector, alarm works only when all circuits are chosen. The function can be reset by turning the CCR off.

Current fault monitoring (in the FAA-monitor card)

If the current in the circuit differs from the set value but is between over-and under current values (no tripping), the red "Current fault" led on the FAA-monitor will light. The function can be reset by turning the regulator off.

d) Main mother board IDM 7000-04

This card connects the plug in cards with each other and contains also most of the remote control indication relays and the rectified power supply for the electronics.

e) Earth fault monitor IDM 7000-05 and mother board (Optional E)

This optional card includes measuring and monitoring electronics, individual power supply and is galvanically isolated from the other electronic cards.

If the isolation resistance of the circuit decreases under the set value first red "Earth fault a" will lit. If the isolation resistance decreases further, also red led "Earth fault b" will light. The isolation resistance can be read from the M-ohm meter on the front panel. The function is always on when the CCR is energised and can be reset by turning off the main switch S1.

NOTE ! Current limited 100 VDC measuring voltage is always on the circuit, when the CCR is energised. Switch off the main switch when doing maintenance works with the circuit!

f) Circuit selector IDM 7000-07 and mother board (Optional)

This card includes remote and local control logic for the circuit selector

3. OPERATING THE CCR

3.1 CONTROLS

a) Main switch

The switch S1 energises the regulator and the green "Power" led will lit on logic unit.

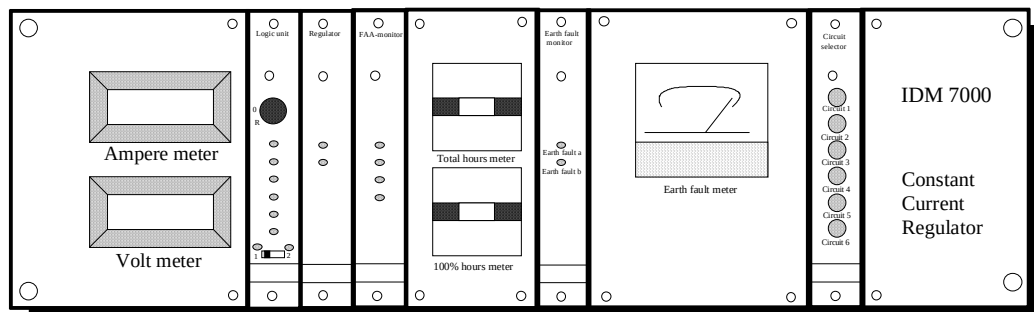


Figure 11. Local control panel of the constant current regulator IDM 7000

b) Operation switch

The regulator can be operated with the operation switch on the logic unit as follows.

- R = Remote control operates only in this position. Switch disables direction changer and circuit selector from local controls.
- 0 = Regulator is off. Position resets protection and monitoring functions.
- % = Regulator is on with desired brilliancy step which can be seen from the yellow LED on the logic unit.

c) Direction changer switch (optional)

If the regulator is equipped with a direction switch, the direction can be selected in local mode. Direction 1 is the main direction (bigger load). LED will show the selected direction in remote and local modes

d) Circuit selector push-buttons (optional)

If the regulator is equipped with the circuit selector the circuits can be selected with these buttons. When the button is pressed down the circuit is selected and the button lit. When the button is pressed again, the circuit and the led will turn off. When switching off circuits, the regulator will provide a special low current to protect the lamps from surges.

3.2 METERS

a) Digital Volt and ampere meters

Current and voltage TRMS-values can be read from the digital meters on the front panel.

b) Operating hour counters

Counters show operating hours for total and 100% (max. brilliancy level) hours.

c) Insulation resistance meter (Optional)

Actual insulation resistance can be read from the meter on the front panel. Range from 10 Mohm down to 10 kohm. The function is always on when the CCR is energised.

4. INSTALLATION

IDM 7000 constant current regulators are supplied in 3 different modular cabinets.

Table 5. IDM 7000 cabinets: width 660mm, depth 500mm for all units

Type	height	CCR sizes
1U	450	3 kVA and smaller
2U	900	4-12kVA
3U	1350	15kVA and larger

All cabinets are free standing and can be installed on a cable pit on the floor or by using IDM 7000-IS installation rack system which allows stacking and therefore provides a space saving assembly. The bottom plate of the 2U and 3U cabinets is lifted 10 cm from the floor plane to allow trucks and lifting devices to be used.

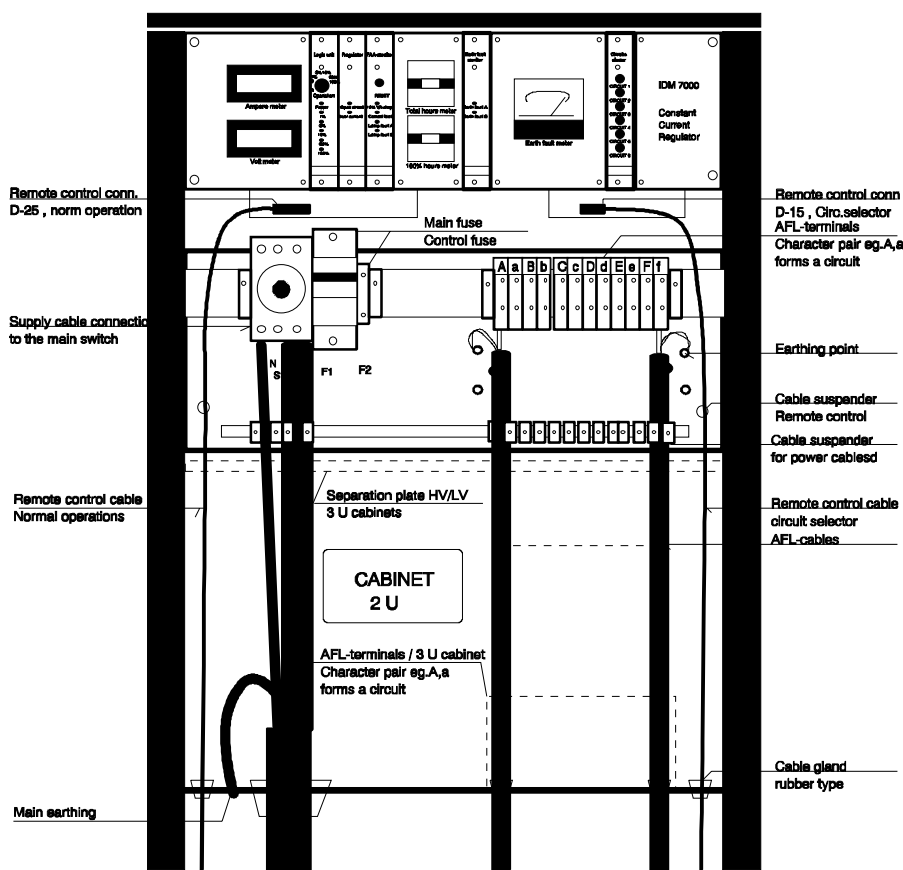


Figure 12. Mounting example of IDM 7000 (U2 cabinet)

- Rubber cable glands are provided for all cable entries.
- Supply cable is connected directly to the main switch S1 terminals and main grounding on the bottom plate.
- Airfield lighting cables are connected to their terminals according the wiring diagram supplied with the regulator. A character pair defines a circuit i.e. A, a. If the CCR is with direction change, connect the main (bigger) load to direction 1 (A, a) and smaller load to direction 2 (B, b). This is related with the FAA-monitor load balancing functions. Ground points are located on the mounting plate. In 3U cabinet the output terminals are located in the lower high-voltage compartment.

- Remote control cables are connected with D-connectors to the mother boards. See Figure 13 and Table 6 and Table 7 for connection details. The cables can be fixed with cable suspenders installed in a rail on the mounting plate.



Figure 13. D-connectors of the remote control

Table 6. X7 (D-25) signals of the remote control

Pin	Signal	Group	Remark
1	Control step 1 (A)	R	Normal or binary coded mode, steady signal, 24/48/60V DC selectable
2	Control step 2 (B)	R	Normal or binary coded mode
3	Control step 3 (C)	R	Normal or binary coded mode
4	Control step 4	R	Normal mode
5	Control step 5	R	Normal mode
6	Control step 6 (D)	R	Normal or binary coded mode, D-mode: start, failsafe, direction
7	Gnd (0 V, -), control	R	Common gnd for controls
8	Common ind 1	PI, FI	Indication group 1 common. Max 60V DC potential free
9	On-indication	PI	NO= Contact closed when the CCR is on, power off state=0
10	Common fault indication	FI	NC, Includes :mains failure, over/undercurrent, 10%VA-drop and current fault
11	Local indication	FI	NO, Contact on when the operation switch is out of "R" (remote) position
12	Lamp fault indication a	FI	NO = Contact closed when the fault exists
13	Lamp fault indication b	FI	NO
14	Earth fault indication a	FI	NO
15	Off indication	PI	NC =Contact closed when CCR is off .Power off state=1.
16	Earth fault indication b	FI	NO
17	Remote-indication	FI	NC, Contact is on when the operation switch is in "R" (remote) position
18	Aux. On-indication (direct)	FI	NO Contact is on when the CCR is on
19	VA-drop indication	FI	NO optional
20	Current fault indication	FI	NO optional
21	Open circuit indication	FI	NO optional
22	Over current indication	FI	NO optional
23	Common ind 2	PI, FI	Indication group 2 common
24	Direction indication / direction 1	PI	NO, Option. Indication when the regulator and the selected direction is on
25	Direction indication / direction 2	PI	NC, Option. Indication when the regulator and the selected direction is on

Table 7. Control signals of X13 connector (D-15).

Pin	Signal	Group	Remark
1	Control, circuit 1		1=on,0=off,steady signal 24/48/60 V DC selectable
2	Control, circuit 2		
3	Control, circuit 3		
4	Control, circuit 4		
5	Control, circuit 5		
6	Control, circuit 6		
7	Indication, circuit 1	PI	NO= Contact closed when circuit is on, power off state =0
8	Indication, circuit 2	PI	NO
9	Indication, circuit 3	PI	NO
10	Indication, circuit 4	PI	NO
11	Indication, circuit 5	PI	NO
12	Indication, circuit 6	PI	NO
13	Indication, circuit 1	PI	NC
14	Gnd (0V,-)		Control and indication (ind. mode) common
15	Spare		

If programmable remote control system is used, following indications can be programmed to the system and be inferred from the control status, on, local and common fault signals:

a) Supply voltage fault -indication (Mains failure)

CCR is not on and not controlled on and not in local mode and common fault exists

b) VA-drop/current fault indication (Vac fall)

CCR is on and Common fault exists

c) Under current/Over current indication (Oc Ucal)

CCR is off and common fault exists and (CCR is controlled on or is in local control)

d) Current step indication

Step is controlled on and on indication exists and common fault is off
Following indications are available as options.

- Current step information, 6-steps, NO-contacts, extra terminal block

Normal delivery includes following components and documents:

- Constant current regulator IDM 7000
- IDM EB extension card 1pcs/CCR
- Accessory package (fuses, screws, cable connectors etc.)
- Technical document T-7000-01d for IDM 7000
- Circuit diagrams: main circuit diagram, remote control connection
- Spare parts list
- Factory test report
- Commissioning test report (blank)

5. COMMISSIONING

First test run should be done with dummy load because the CCR can be damaged during storage or transportation.

- Connect an TRMS A-meter (AC-range) in series with the test load and connect a DC-voltmeter to the measuring points MP1 (0V) and Iact (current actual value) on regulator card.
- Run CCR with all brilliancy steps to be sure that they are working properly and check that readings of the meters are same. If the output on any step is more than 6,6A adjust it lower with trimmers P1-P6.

After checking that the CCR and series circuit is OK, commissioning can be done with the actual circuit. Fill in the measured values to the commissioning test report supplied with the regulator.

5.1 SERIES CIRCUIT

Before running the actual circuit with CCR, following values of the circuit should be measured and recorded.

- Calculated circuit load.

Insulation resistance to the ground (>10 Mohm is good, down to 100 kohm can be tolerated). Check that the circuit is disconnected from the CCR when testing. Use at least 500V DC tester. Discharge the circuit before touching the cable conductors.

- Continuity of the circuit (typical values less than 100 ohm). Multimeter can be used.

5.2 LOGIC UNIT IDM 7000-01

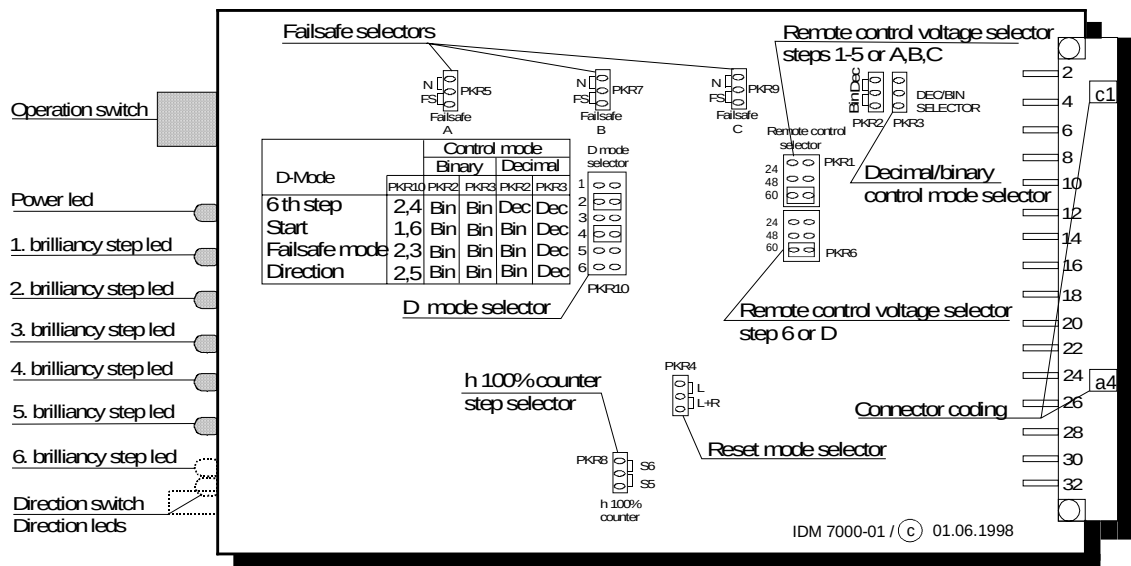


Figure 14. Logic card IDM 7000-01c

a) Remote control voltage selector

24V, 48V and 60V DC can be selected. Check that the remote control voltage selector settings conform with the voltage used in the system. Jumpers are used for the selections.

b) Remote control mode Dec/bin-selector

Check that the control mode selector conforms with the mode used in the control system.

- Dec (decimal) means normal control where for each brilliancy step one constant signal is provided. No two step signals should be present at the same time.
- Bin (binary) the control signals are given in binary coded from a, b, c. See Table 8.

Table 8. Binary control signals

signal/step	P1	P2	P3	P4	P5	P6
A	x		x		x	
B		x	x			x
C				x	x	x

c) D-mode selector

With D-mode selector the D-input (pin no 6 in X7) can be used as follows.

- **6th step** enables remote control input to be used for 6th brilliancy step in Dec mode.
- **Start** requires independent start signal with step control. The feature is useful if the CCRs in the same sub-system eg. Apch, twye need to have an individual on/off control.
- **Fail-safe** sets the CCR to third brilliancy step in case the control signal would be missing from pin D and the CCR is in remote control mode. This feature starts the CCR automatically in case of remote control DC voltage failure.
- **Direction** mode is used when the regulator is equipped with the direction changer which allows one regulator to feed two opposite directions.
 - direction 1 (default), off signal, logic null
 - direction 2, on signal, logic one

d) 100% counter step selection

6th or 5th step can be selected to run the 100% operating hour counter.

e) Reset mode selector

CCR can be reset locally or remotely. If the jumper is set to L- position then CCR can be reset only by turning the operation switch or main switch to OFF-state. If jumper is L+R -position then CCR can be reset by switching the remote control or operation switch to OFF-state.

5.3 REGULATOR UNIT IDM 7000-02

The regulator is calibrated and pre-set at the factory but however calibration of the regulator is good to check during the commissioning and also regularly in use. For adjustments following tools are needed:

- IDM-EB extension board
- Calibrated TRMS ampere meter (10A) and multimeter (DC-range)
- Small screwdriver

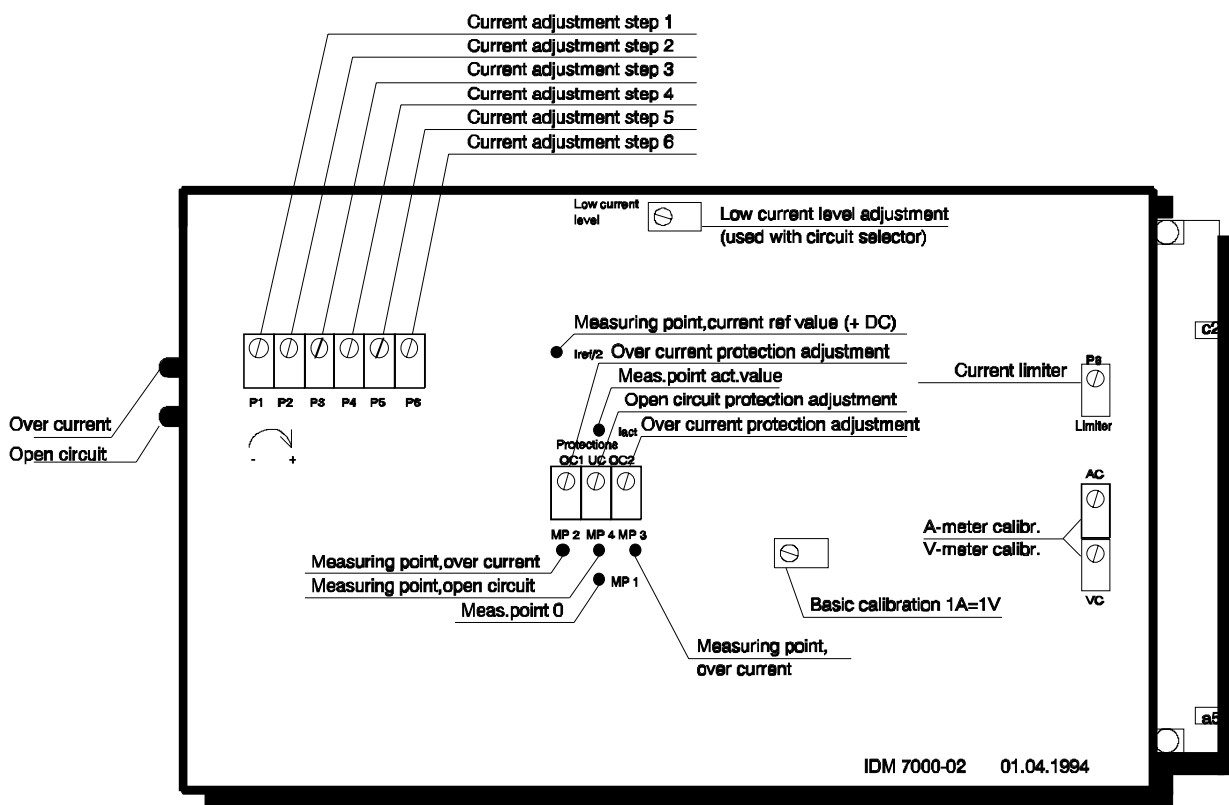


Figure 15. Regulator card IDM 7000-02b

1. Basic calibration (1A actual current = 1V on the card)

- Connect an TRMS A-meter in series with an actual load.
- Adjust trimmer P5 (P6) 1 turn counter-clockwise to be sure that current does not exceed 6.6A.
- Measure an actual value with a volt meter from the measuring points MP6 (Iact), MP1.
- Select the highest brilliancy step and check that the readings of the two multi meters are the same. 1A actual current means 1V DC on the regulator card. If needed, adjust the actual current with trimmer "**Basic calibration**" to obtain 1A=1V. Please note that calibration changes the actual current in the circuit.
- Check/calibrate the CCR's digital A-meter with trimmer Ac.

The digital voltmeter is calibrated at the factory, however if it is needed to be calibrated it can be done as follows.

- Measure the incoming AC voltage from regulator card terminals' 28c and 32c (U_m).
- Calculate the correct voltage display with following formula

$$Display = \frac{U_m}{20V} \cdot \frac{S}{I_2}$$

S =CCRs maximum power, I_2 =maximum current (normally 6,6A)

Calibrate the display with trimmer Vc if needed.

2. Current steps

Adjust the desired current steps with trimmers P1-P6.

Table 9. Brilliancy steps and equivalent current values

6 step/trimmer	5 step/trimmer	brilliancy /%	actual current /A
P1		0,3 %	2,8 A
P2	P1	1 %	3,3 A
P3	P2	3 %	3,8 A
P4	P3	10 %	4,6 A
P5	P4	30 %	5,4 A
P6	P5	100 %	6,6 A

3. Open-circuit protection (Undercurrent)

- Select the 1st brilliancy step
- Test the open circuit protection by adjusting trimmer Uc clockwise until protection operates (see figure 9 on page 10).
- Exact tripping value can be measured from test points MP1 (gnd) and MP4 (Uc). Adjust the trimmer Uc to obtain desired tripping value (e.g. 1,5V = 1,5A).

4. Over-current protections

- Select the highest brilliancy step.
- Adjust trimmer Oc1 slowly counter-clockwise until the CCR trips within 5 sec (see figure 9 on page 10). Exact tripping value can be measured from test points MP1 (gnd), MP2 (Oc1)
- Adjust trimmer Oc2 slowly counter-clockwise until the CCR trips (within 1 sec). Exact tripping value can be measured from test points MP1 (gnd) and MP3 (OC2).
- Adjust the desired tripping values e.g. 6,7V (OC1) and 6,8V (OC2).

5. Current limiter

This protection limits CCR's maximum voltage and thus the current if the over-current protection does not trip the CCR.

- Select maximum load and the highest brilliancy step.
- Adjust trimmer P8 "Current limiter" slowly counter-clockwise until current begins to drop.
- Adjust trimmer P8 one full turn clockwise.

6. Low current level adjustment (CCRs with circuit selector)

This feature protects the lamps from over current surges when switching off loads with the circuit selector

- Adjust the trimmer in such a way that when switching off all the rest of the load while the smallest load stays on, the current should not exceed 6.6A. The current is reduced by turning the trimmer low current level clockwise. Adjust it to 4A.

5.4 FAA-MONITOR UNIT IDM 7000-03d (option)

The monitor has following functions which need to be adjusted with the actual load during commissioning. The monitoring of lamp faults is based on a voltage curve measurement and the monitoring of VA-drop is based on a RMS voltage measurement.

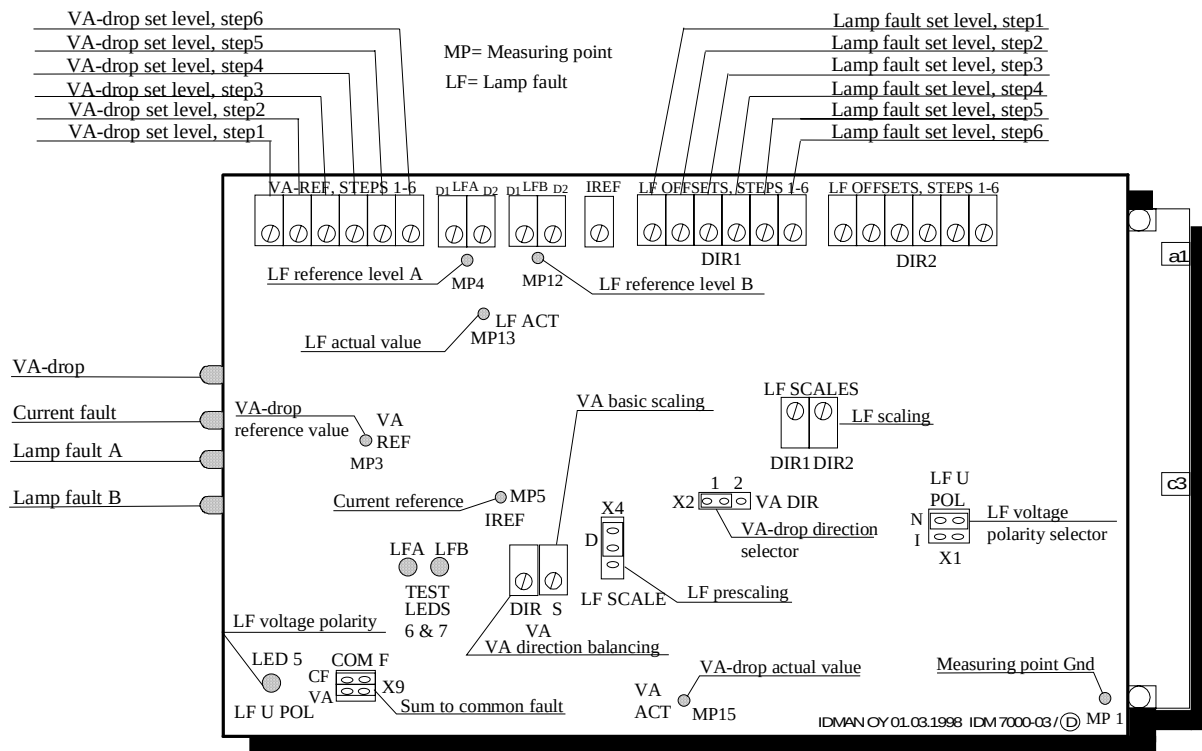


Figure 16. FAA-monitor card IDM 7000-03d

5.4.1 Lamp fault settings

The following tools are needed:

- 2 pcs TRMS multimeters
- Small screw driver for trimmers

Trimmings and settings will be done as follows:

1. **Check that all lamps are functioning before adjusting the lamp fault monitor!**
2. Switch the CCR OFF and disconnect power by the main switch or main fuse.
3. Remove the FAA-monitor card.
4. Insert the extension board to CCR.
5. Connect the monitor card to the extension board.
6. Turn the power ON and switch the CCR ON.
7. Check the LED 5. If LED is bright clearly on each current step the jumper on the terminal X1 is set to wrong position. Turn the power OFF and change position of the jumper on the terminal X1 (LF voltage polarity selector). **N=Normal, I=Inverse. NOTE!** If the polarity of lamp fault voltage is opposite the lamp fault voltage is negative.
8. Turn the power OFF. Connect VDC-meter between GND (MP1) and Iref (MP5). Turn the power ON and check voltage. The current reference value should be 0,50 VDC (Factory setting). If Iref is not correct adjust voltage to 0,50 V DC by trimmer Iref.
9. Turn the power OFF and connect VDC-meter to GND (MP1) and LF ACT(MP13) Check that the jumper of the terminal X4 is set to position D (decrease). If not, change it.

10. Turn the power ON and switch the lowest level ON (first step). Adjust the "Offset" voltage to 0,00 V DC with trimmer LF OFFSETS STEP 1 (DIR1).
11. Disconnect one lamp from the circuit. Adjust or scale LF voltage to about 0,2 - 0,4 V DC with trimmer DIR 1 (LF SCALES).
12. Reconnect the lamp. Adjust again the "Offset" voltage to 0,00 V DC with trimmer LF OFFSETS STEP 1.
13. Change intensity to step 2 and adjust "Offset" to 0,00 V DC with trimmer LF OFFSETS STEP 2.
14. Repeat with steps 3 to 5 (or 6).
15. Basic calibration of lamp fault monitor is completed.

Next proceed with choosing and setting of alarm limit A:

1. Switch the CCR OFF and turn the power OFF.
2. Define and choose how many lamps shall give alarm A (LF A).
(Normally 5 - 10% of total amount)
3. Connect the first VDC-meter to MP1 (GND) and MP4 (LF A).
4. Connect the second VDC-meter to MP1 (GND) and MP13 (LF ACT).
5. Disconnect chosen amount of lamps from the circuit for the first alarm level A.
6. Turn power ON and switch CCR ON in step 1.
7. Read and note the actual lamp fault voltage (LF ACT).
8. Adjust LF reference value A slightly lower than LF ACT with trimmer LF A, D1.
Check that the test LED 6 (LF A) just lit up stabile. Record the LF A value up.
9. The setting of alarm level A is completed.

Next proceed with choosing and setting of alarm limit B:

1. Switch the CCR OFF and turn the power OFF.
2. Define and choose how many lamps shall give the second alarm B. (Normally 15% of total amount)
3. Disconnect chosen amount of lamps in the circuit.
4. Change the first VDC-meter to MP1 (GND) and MP12 (LF B).
5. Turn the power ON and switch the CCR ON in step 1.
6. Read and note the actual lamp fault voltage (LF ACT).
7. Adjust LF reference value B slightly lower than LF ACT with trimmer LF B, D1.
Check that the test LED 7 (LF B) just lit up stabile.
8. Switch the CCR OFF
9. Reconnect the all lamps.
10. The setting of alarm level B is completed.

Check the function of alarms:

1. Switch the CCR ON. Disconnect lamps one by one with an interval of one minute until the alarm level A comes. The first alarm should appear at chosen amount of lamps. Detection of alarm is shown on the test LED's before they occur on the front of panel. Test and notify the function of the alarm on all intensities by changing intensity step. Wait one minute for detecting alarms.
2. Disconnect more lamps until the alarm level B occurs. Proceed as above.
3. Checking and inspection is completed.

CCR with direction changer:

If CCR is equipped with direction changer feature, the lamp fault trimming and settings to direction 2 should be done in a same way as to direction 1. For direction 2 the card has own trimmers. The trimmers have been marked by DIR2

or D2. Examples: (LF OFFSETS STEPS 1-6, DIR2), (LF SCALES, DIR2), (LF A, D2) and (LF B, D2). **NOTE!** The current reference is a basic setting. The same value is used for both directions. It is necessary to check and set it only once (in direction 1). Also LF polarity selection is same to both directions.

5.4.2 VA-drop settings

VA-drop scaling

1. Measure actual value of VA-drop with DC-voltmeter across measuring points MP1 (GND) and MP15 (VA ACT)
2. If the CCR is with direction changer, do the scaling with the smaller load (Direction 2) and balance the value of direction 1 to be equal to direction 2 with trimmer VA/dir.
3. **Note!** CCRs with direction changer: The jumper of VA-drop direction selector is set to position 1 at the factory. If the smaller load is connected to direction 1 and the bigger load is connected to direction 2, the jumper of the terminal X2 must be changed to position 2.
4. Select the maximum brilliancy step and load (if CCR is with circuit selector) and scale the actual value to 8V with trimmer VA/S. Maximum value depends on ratio of CCR output power and load (4-8V is OK).

VA-drop indication

1. Record the actual values (U_{act}) for each brilliancy step to the commissioning test report.
2. Calculate the desired reference values for each step by using formula below.

$$U_{ref} = U_{act} * \left(\frac{100 - x}{100} \right)$$

U_{ref} desired reference voltage

U_{act} measured actual values of a faultless circuit (V DC)

x power drop, in per cent, desired to cause alarm (normally 10%)

3. Measure reference value of VA-drop with DC-voltmeter across measuring points MP1 (GND) and MP3 (VA REF)
4. Adjust the reference values for each brilliancy step with trimmers VA-drop 1-6 and record them to the commissioning test report.

Other setting

1. **Common fault indication** selector will abort Cf (current fault) and VA-drop alarms from the common fault alarm and thus will leave only mains failure indication to the common fault.

5.5 EXTRA MONITOR UNIT IDM 7000-09a (option)

The card includes extra monitoring functions with over current protection. Settings are pre-set at the factory.

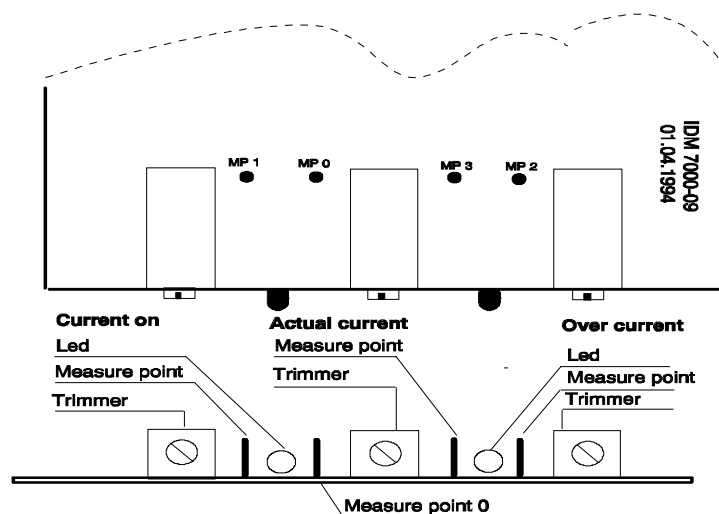


Figure 17. Extra monitor card IDM 7000-09a

a) Basic calibration

- Connect DC volt meter to test points MP0(ground) and Iact (actual value).
- Select the highest brilliancy and check that the reading is same as the reading on CCR's current meter. Adjust with trimmer, P1 if needed.

Current measuring on the card is based on rectifying and is not exactly the same as TRMS-value. If meter is calibrated with 6,6A reading with 3,3A is approximately 3A.

b) Current indication

- Select the lowest current step and check the "current on" limit from the test points MP0(ground) and Uc. Normal value is 1,5V (=1,65A). Check also that the green LED is on and the indication relay operates.
- Adjust "current on" limit higher than the actual value (>3A) whit trimmer P2. Check that LED turns off and relay operates (connect is open).
- Set the limit back to 1,5V(=1,65A).

c) Over current protection

- Connect the highest current step and turn the current trimmer OC1 counter-clockwise until the CCR strips.
- Turn the trimmer 1/3 turn clockwise.

5.6 EARTH FAULT MONITOR IDM 7000-05 (option)

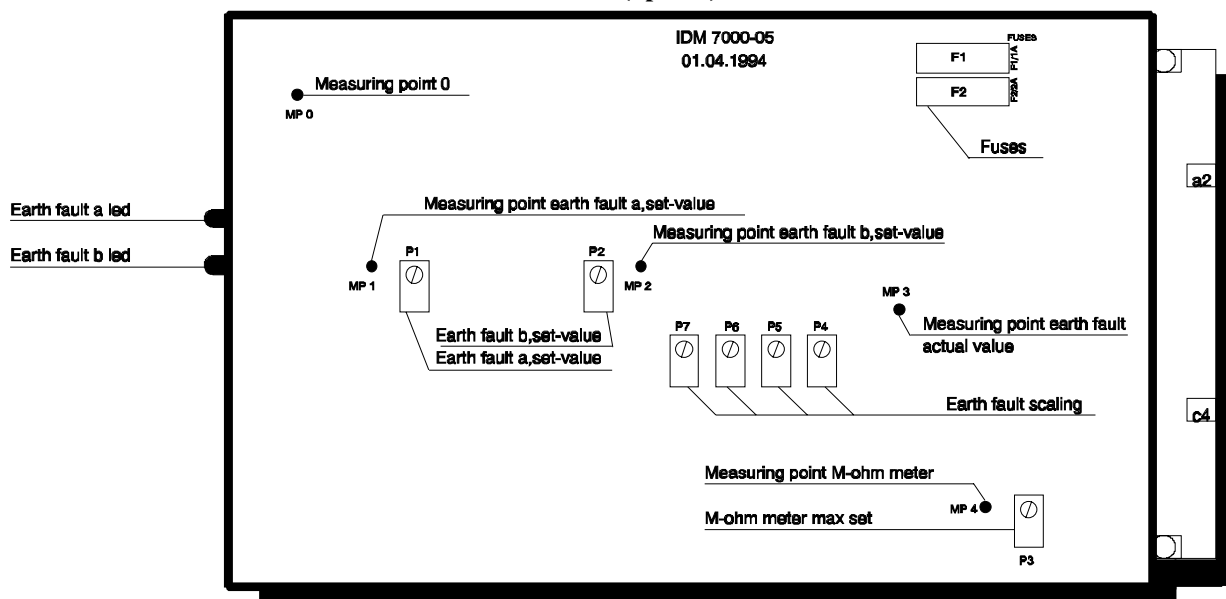


Figure 18. Earth fault monitor card IDM 7000-05

The unit monitors the isolation resistance on which two alarm levels can be set.

- The ref values can be checked from points MP0 (gnd), MP1 (ef a) and MP2 (ef b).
- The ref values can be adjusted with trimmers P1 (level a) and P2 (level b). Factory settings are 1Mohm (level a) and 100 kohm(level b).
- Actual value can be checked from measuring points MP0 and MP3.
- Desired ref values can be taken from figure 19.

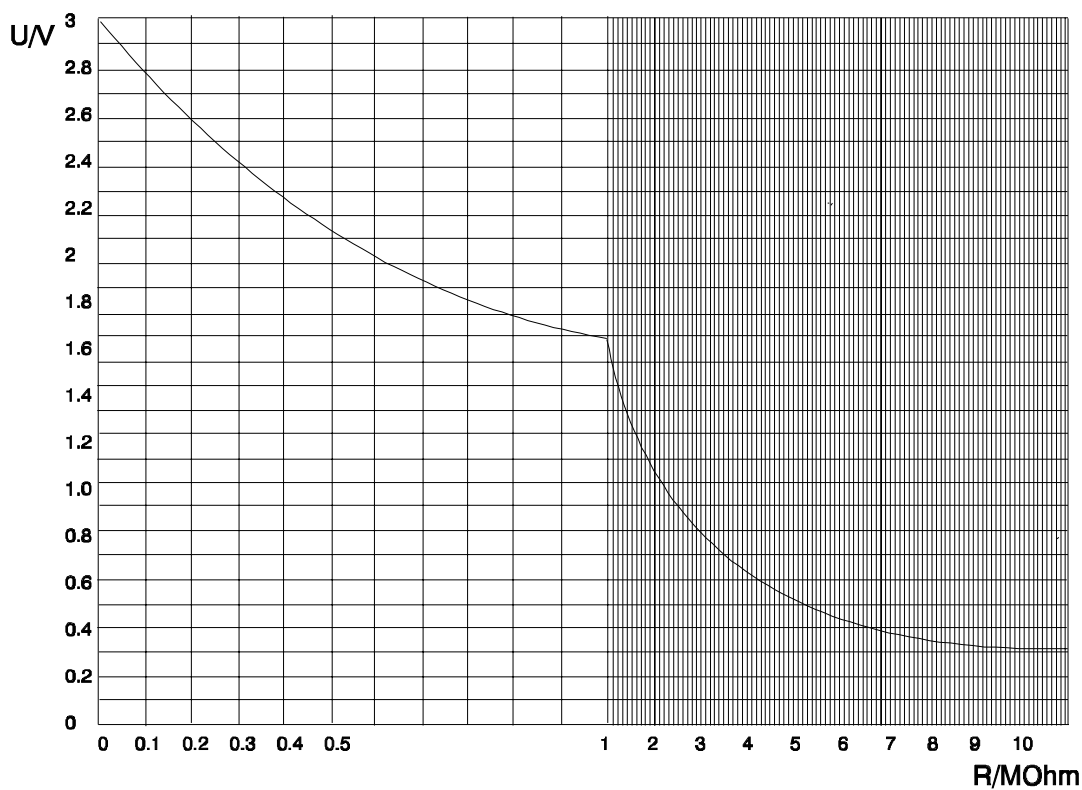


Figure 19. Reference voltage (VDC) as a function of the isolation resistance

5.7 MAIN MOTHER BOARD IDM 7000-04

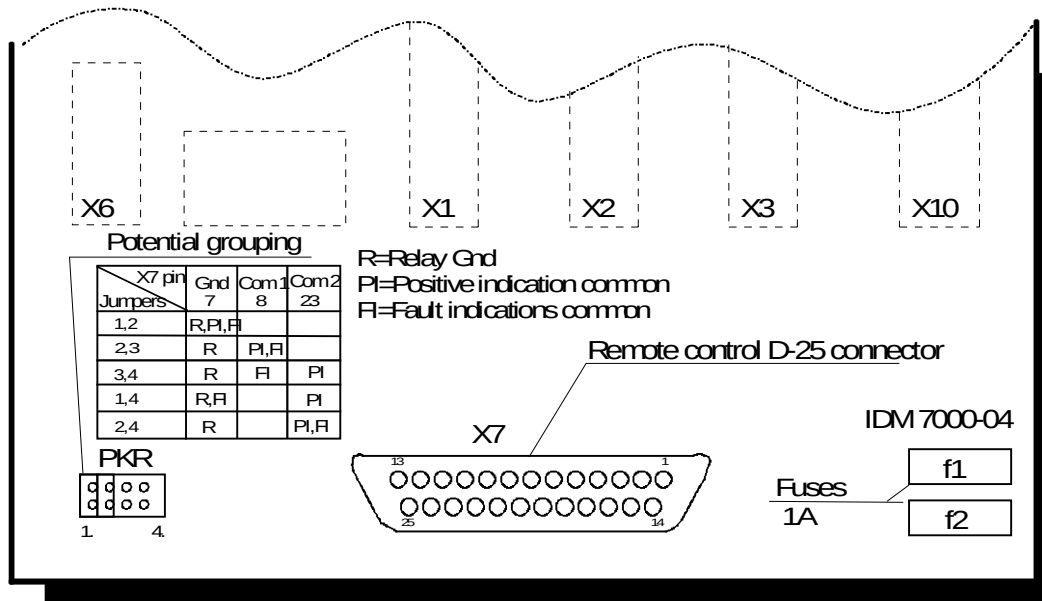


Figure 20. Main mother board IDM 7000-04

Potential grouping selector can connect the indication group commons to certain X7 pins according the table in Figure 20. This may be useful if there are different control, monitoring and alarm systems which need to be galvanically isolated.

Table 10. Control and indication group abbreviations

-R	Common of the control relays, always to be gnd.
-PI	Positive indications (On, direction, circuit indications)
-FI	Fault indications (Local, remote and all fault indications)

5.8 CIRCUIT SELECTOR MOTHER BOARD IDM 7000-08

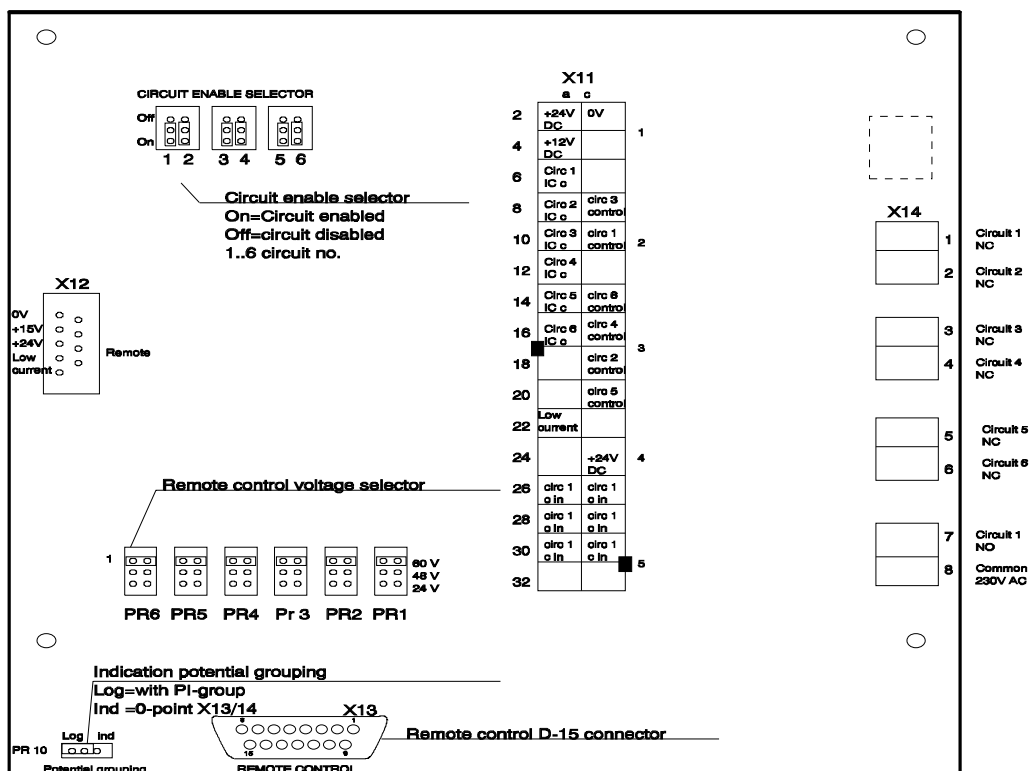


Figure 21. Circuit selector mother board IDM 7000-08a

a) Remote control voltage selector

Check that the remote control voltage selector settings conform with the voltage used in the system. 24/48/60V DC can be selected with jumpers PR1-PR6 for each circuit.

b) Indication potential grouping selector

With Indication potential grouping selector the indications of the circuits can be arranged as follows.

- Log (Pos 1). Circuit indications are connected to positive indications (PI) of the main mother board and are mastered by the on relay. The indications are only given when the regulator is on .
- Ind (Pos 2). Indications are grouped to X13/14 terminal (Control relays common) and the indications are given even if the regulator is off.

c) Circuit enable selector

Selector defines which circuits are used. On-position means that the circuit is enabled and off that it is disabled. This function is related with the lamp fault and VA-drop monitoring functions and need only be changed if the number of circuits in the CCR is modified.

5.9 MAIN TRANSFORMER

The main transformer T1 is fitted with three tapings both on primary and secondary sides. This is to match possibly oversized regulator better with actual load by changing the ratio of the transformer. The matching can be done in 5% steps according the table in Figure 22.

Please note that approx. 5% reserve should be left for under voltage conditions and that the adjusting should be done first on the secondary side.

220V Supply voltage			230V Supply voltage			240V Supply voltage		
Primary tapping	Secondary tapping	CCR capacity	Primary tapping	Secondary tapping	CCR capacity	Primary tapping	Secondary tapping	CCR capacity
220V/1A1	100%/1a3	100%	230V/1A2	100%/1a3	100%	240V/1A3	100%/1a3	100%
	90%/1a2	90%		90%/1a2	90%		90%/1a2	90%
	80%/1a1	80%		80%/1a1	80%		80%/1a1	80%
230V/1A2	100%/1a3	95%	240V/1A3	100%/1a3	95%			
	90%/1a2	85%		90%/1a2	85%			
	80%/1a1	75%		80%/1a1	75%			
240V/1A3	80%/1a1	72%						

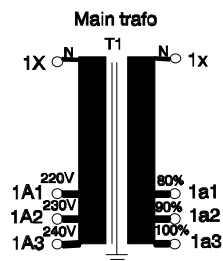


Figure 22. Fitting a CCR to load whit different supply voltages

The matching is done by connecting the transformers incoming line wire to one of the terminals 1A1,1A2 and 1A3.And respectively the outgoing line cable to one of the terminals 1a1,1a2 and 1a3.Please note that no higher voltage should be given to primary taps as is given in the table of Figure 22. eg connecting 240V to 1A1 (220V tap) is not allowed

Proper matching will reduce the primary current, improve the efficiency and the power factor and also reduce the harmonic distortion.

5.10 COMMISSIONING CHECK LIST

1	1 Check the afl-circuit
	-Load
	-Continuity
	-Isolation
2	2 Remote control and pre-set settings
	-Remote control voltage settings ;logic unit and circuit selector mother board
	-D-mode selector ; logic unit
	-Potential grouping settings ; main and circuit selector mother boards
	-Main transformer tapping
3	3 Calibrations/regulator card
	-Basic calibration 1A=1V
	-A/V -meters
4	Protections/regulator card
	-Open circuit
	-Over current settings
	-limiter
5	Performance/regulator card
	-Current step settings
	-Low current level
6	FAA-monitor
	-Lamp fault; off-set (null), scaling, actual and set values
	-10% VA-drop ; scaling, actual and set values
	-Reset type
7	Extra monitor
	-Calibration
	-Current indication
	-Over current protection
8	Earth fault monitor
	-Actual and set values
9	Remote control function test
	-Controls, logic unit and circuit selector mother board
	-Indications

6. TROUBLE SHOOTING

The regulator is set up on plug in euro cards. Trouble shooting is practical to do simply by replacing new cards. Please note following remarks:

- Turn the CCR off when replacing cards**
- Use test load during trouble shooting if possible.**

6.1 SUPPLY VOLTAGE CHECK

This check should be done always after serious damage (for instance lightning) or when power - LED does not lit despite that the CCR is on.

- Take off all the with drawable cards.
- Measure the DC power given to the regulator card (7000-02) with the extension card.

Table 11. Incoming power voltages for the regulator card

Connector	Voltage /DC	explanation
28c/30c	+20 V DC	Power +
28c/30a	-20 V DC	Power -

- If voltages are not correct, check the mother board and the DC power transformer T4.
- If voltages are OK, insert the 7000-02 card and measure following DC voltages.

Table 12. Power voltages provided by the regulator card

Connector	Voltage /DC	explanation
28c/2c	+12 VDC	Regulated +DC supply
28c/2a	-12 VDC	Regulated -DC supply
28c/26c	+5 VDC	supply for meters
28c/26a	+24 VDC	supply for relays

If the given voltage values are not correct, replace the regulator card. Please note that incorrect values may damage the other cards

If values are OK you may try inserting the other plug in cards.

6.2 CCR WILL NOT START AT ALL

- Check the supply voltage and fuses. The supply voltage can be easily seen from the "Power" led on the logic unit provided that the main switch is on.
- Check if % led is lit on the logic card when switched on. If not replace the logic card.

6.3 CCR GIVES AN OPEN CIRCUIT ALARM

- Check continuity of the secondary circuit
- Check the open-circuit protection level (Uc)
- Start the CCR and check following.
 - If current is practically 0A and voltage gets very high, check the current trafo and its wiring ,power circuit wirings and components and change the regulator card if necessary.
 - If the current and voltage are too low, check the current set level and change the regulator card if necessary.
 - If the current and voltage starts normally, check the open-circuit protection level.

6.4 CCR GIVES AN OVER CURRENT ALARM

- Check the over-current set levels (Oc1 and Oc2)
- Check the fuses and the power voltages of the regulator card
- If possible use test load and try CCR with the lowest brilliancy step
 - Check the brilliancy step levels and change the regulator card if necessary

6.5 CCR IS ON BUT CURRENT SEEMS TO BE UNSTABLE

Check the grounding of the CCR. Bad grounding can cause unstability to sensitive electronic circuits especially with larger CCRs.

6.6 MAIN FUSE IS BLOWN

- **Do not try to start before component and wiring checks.**
- Check power circuit for short circuits and also isolation against the ground.
- Check the thyristor module, thyristor controller and the regulator card
- Do not try to start many times if the fuse blows but instead check carefully each component of the circuit.

7. MAINTENANCE

7.1 PREVENTIVE MAINTENANCE

A maintenance programme, including preventive maintenance where appropriate, should be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation. (ICAO Annex 14, 2:nd edit. page 109)

According to ICAO Annex 14 a light fitting is unserviceable when:

- It's main beam is out of alignment
- It's average intensity is below 50% of the specified value.

Preventive maintenance requirements are divided into following categories.

7.1.1 CAT II, CAT III preventive maintenance requirements

- All approach and runway lights are serviceable and in all cases at least as in Table 13.

Table 13. Availability of a CAT II and CAT III systems

Serviceability	Lighting subsystem
95%	CAT II and CAT III approach lighting system (innermost 450 m)
	Runway centreline lighting system
	Threshold lighting system
	Runway edge lighting system
90%	Touchdown zone lighting system
85%	Approach lighting system
75%	Runway end lighting system

Lighting pattern must keep its form despite of light fitting failures.

Failure in two adjacent light fittings is not permitted except in a barrette or a cross-bar where two adjacent light fitting failures are permitted.

7.1.2 Preventive maintenance recommen of the stop-bar lighting system (RVR<350 m)

- Maximum two light fittings are unserviceable.
- Two adjacent fittings are not faulty unless the spacing between them is reduced.

7.1.3 Preventive maintenance recommendations of the taxi way lighting system (RVR<350 m)

- No two adjacent fittings are unserviceable.

7.1.4 CAT I preventive maintenance recommendations

- All approach and runway lights are serviceable and in all cases at as shown in Table 14.

Table 14. Availability of a CAT I system

Serviceability	Lighting subsystem
85%	Approach lighting system
	Threshold lighting system
	Runway edge lighting system
	Runway end lighting system

- Lighting pattern must keep its form despite of light fitting failures.
- Failure in two adjacent light fittings is not permitted unless the spacing between them is reduced.

7.1.5 Preventive maintenance recommendations of RVR <550 m take off runway

- All runway lights are serviceable and in all cases at least as shown in Table 15.

Table 15. Availability of a RVR>550m system

Serviceability	Lighting subsystem
95%	Runway edge lighting system, runway centre line lighting system
75%	Runway end lighting system

- No two adjacent light fitting failures are permitted

7.1.6 Preventive maintenance recommendations of RVR>550 m take off runway

- All runway lights are serviceable and in all cases at least as shown in Table 16.

Table 16. Availability of a RVR>550m system

Serviceability	Lighting subsystem
85%	Runway edge lighting system
	Runway end lighting system

- No two adjacent light fitting failures are permitted

7.1.7 Fulfillment of ICAO:s preventive maintenance objectives

The objective of ICAO cannot be yet fulfilled because at the moment the aligning and light output of each light fitting cannot be monitored at reasonable costs. The serviceability is monitored by monitoring the lamp filament and is done in two ways:

- Centralised system is realized with a lamp failure monitor in a CCR.
- In a distributed system each light fitting has an addressable monitoring unit.

7.1.8 Centralised system with IDM 7000-03 FAA monitor

Reference levels should be set equal and according the preventive maintenance tables for each CCR of a subsystem. Alarms should be connected parallel. First CCR which reaches the level causes the alarm.

7.1.9 Distributed monitoring systems

In distributed monitoring systems every light fitting has an addressable monitoring unit. In this case the percentage values and adjacency requirements can be monitored more efficiently. However even then the first objective of ICAOs recommendation: all fittings serviceable, can not be fulfilled.

7.2 MAINTENANCE OF THE CCR

Following things should be checked at least on a yearly basis.

- Calibration of the meters
- Basic calibration
- Protections levels and functions
- Ventilation is not blocked

The afl-circuit isolation resistance should be regularly checked and tables made to follow the condition of the circuits in time and different weather conditions. Pay attention to next things.

- Disconnect the CCR from the circuit when checking the isolation resistance specially if the regulator is supplied with earth fault monitor.
- Discharge the circuit after measuring before touching the cables
- When CCR is switched on, 100 VDC measuring voltage is connected into the circuit.

Following spare parts are recommended to be kept in stock at site.

- Logic card
- Regulator card
- Thyristor pair
- Thyristor controller
- Fan

7.3 IDM 7000 CARD VERSIONS

As we continuously develop our products following card versions with new features have been developed. The card pictures in this document conform with the latest card versions.

Table 17. Card versions (V= card version, D=generation)

Card	V	D	Date	Feature
01	a	A	15.10.1993	Logic card
	b	C	1.1.1995	Binary coding, direction chance
02	a	A	15.10.1993	Regulator card
	b	B	1.4.1994	Voltage supervisions
03	a	A	15.10.1993	Monitor card
	b	C	1.8.1995	Balancing of direction chance, A/B level control
	d	D	01.03.1998	New method of lamp fault monitoring chanced
04	a	A	15.10.1993	Main mother card
	b	B	1.4.1994	Extra monitor, fault definition, step relays
	c	C	1.1.1995	Chances for 03b
05	a	A	15.10.1993	Earth fault monitor card
	b	B	1.4.1994	Test points, trimming of the resistance meter
06	a	A	1.10.1993	Base card for earth fault monitor card
07	a	A	15.4.1993	Circuit selector card
08	a	A	1.10.1993	Base card circuit selector card
09	a	B	1.4.1994	Extra-monitor card

Cards are compatible with earlier versions, however naturally the new features do not work in connection with cards of earlier generation.

7.4 CUSTOMER FEEDBACK ,RECLAMATIONS AND AFTERSALES SERVICES

As we also develop our products through customer feedback we welcome all comments regarding the quality and performance of the CCR. Reclamations are statistically filed and corrective actions taken immediately. Full repair service is provided for the cards.

Training and commissioning services are also available.

8. TECHNICAL DATA

Input voltage	230V +10/-5% , 50/60 Hz , single phase
Output current	6.6A+1%, regulation from 1,5 to 6.6A 5/6 steps
Power ratings	3; 4; 5; 7,5; 10; 12; 15; 17,5; 20; 25 kVA
	In output connectors, Whit nominal values, matching posipility 30%
Power factor	> 0,95, with rated load and with rated supply voltage
Efficiency	> 90%, with rated load and with rated supply voltage
Remote control	24/48/60 V DC selectable, Connection with D-connector
Ambient temp	-0 C to +55 C, on request from -40 C to +55 C
Protections	Over current/primary, fuses
	Over current/secondary, electronic, 2-levels, tripping
	open circuit/ secondary, electronic, tripping
	Under voltage/ primary, electronic, tripping
Monitors	10% VA-drop ,electronic, all brilliancy steps, 2 directions
	Current fault, electronic, all brilliancy steps
	Lamp fault, electronic, 2-levels, all steps, 2 directions
	Earth fault, electronic, 2-levels
Meters	Ampere (A), TRMS, digital
	Volt (V), TRMS, digital
	M-ohm (earth fault), analogy meter
	Total operating hours, mechanical, digital
	100% operating hours, mechanical, digital
Dimensions	Width: 660 mm Depth 500 mm
	Height 450 mm < 5 kVA
	900 mm 5-15 kVA
	1350 mm >15 kVA
Accessories	IDM 7000-RT remote control tester
	IDM 7500-CT remote control simulator
	IDM 7000-IS Installation rack system

9. APPENDIX 1 : EARLIER CARD VERSIONS

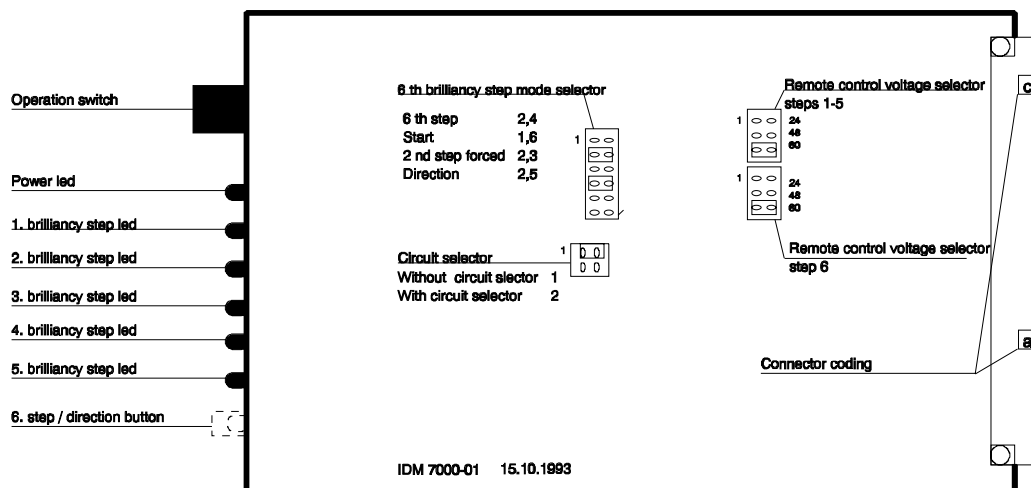


Figure 23. IDM 7000-01a logic card lay-out

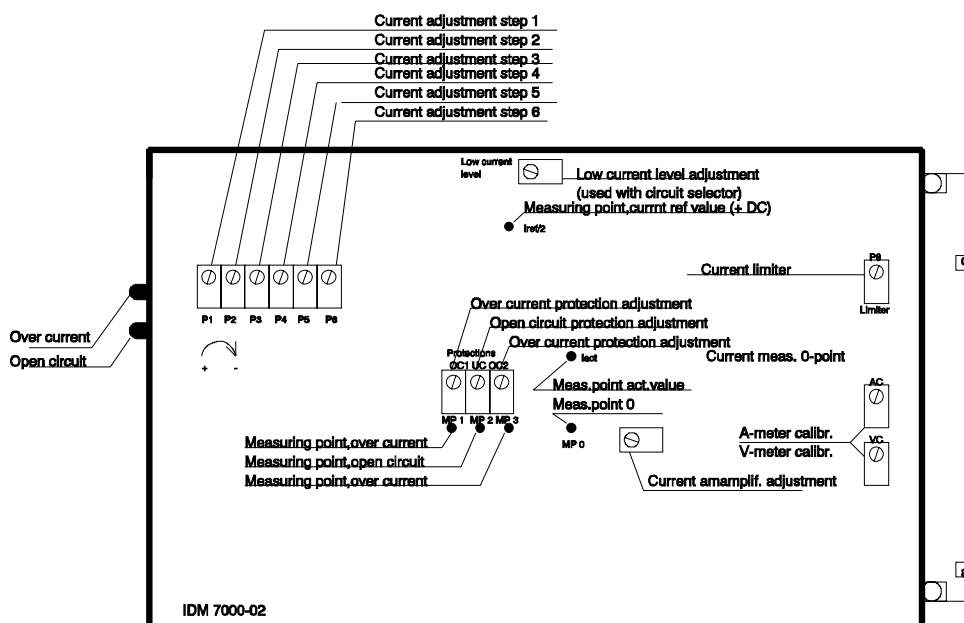


Figure 24. IDM 7000-02a regulator card lay-out

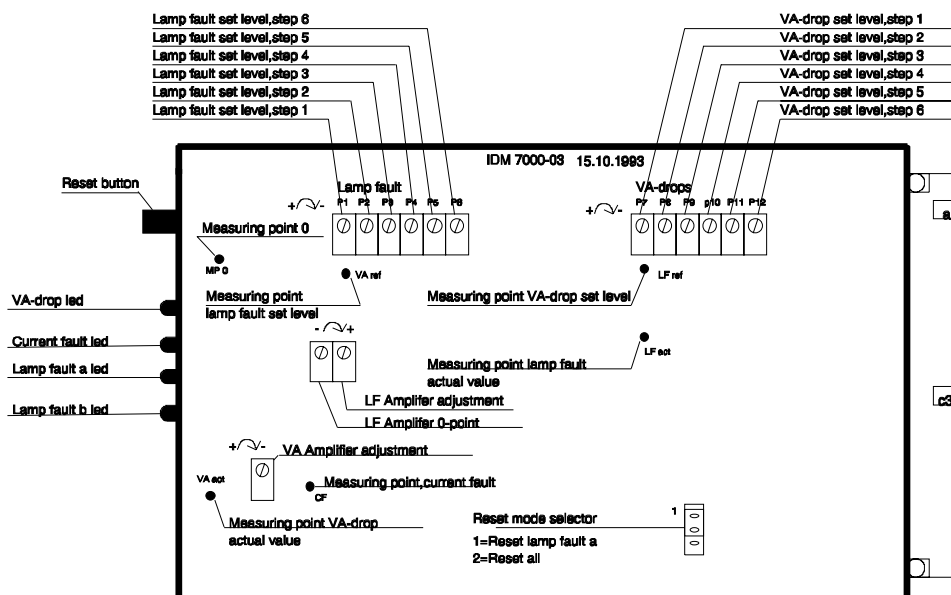


Figure 25. IDM 7000-03a FAA-monitor card lay-out

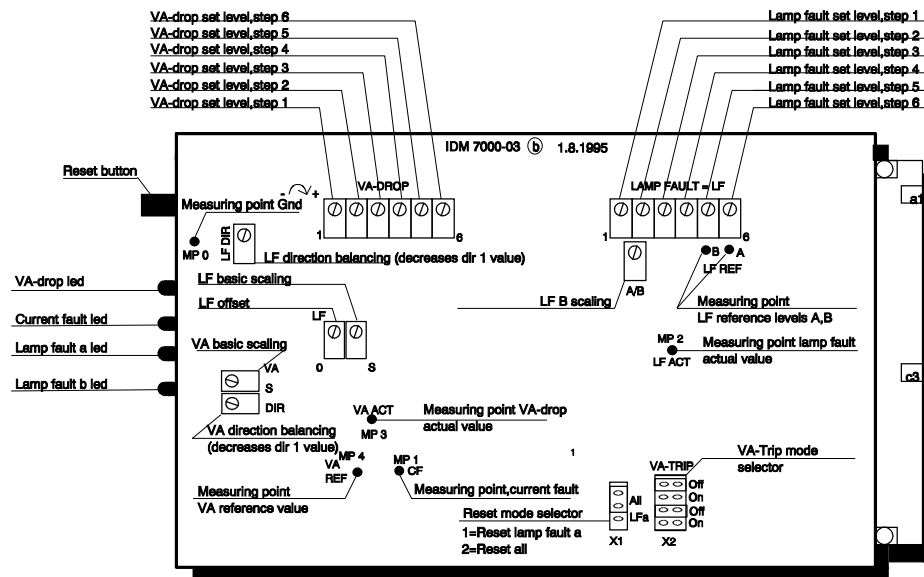


Figure 26. IDM 7000-03b FAA-monitor card lay-out